USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY09 Final Performance Report
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Cover Page

PI:	Erick DeWolf
Institution:	Kansas State University
Address:	Department of Plant Pathology 4607 Throckmorton PSC Manhattan, KS 66506
E-mail:	dewolf1@ksu.edu
Phone:	785-532-3968
Fax:	785-532-5692
Fiscal Year:	2009
USDA-ARS Agreement ID:	59-0790-7-072
USDA-ARS Agreement Title:	Prediction Models and Improved Pre-Harvest Estimates of Deoxynivalenol.
FY09- USDA-ARS Award Amount:	$ 44,506

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
MGMT	Deployment of Models Predicting the Risk of Disease Epidemics and DON.	$ 12,256
MGMT	A First-Generation Model for DON Prediction in Multiple Wheat Classes in the US.	$ 32,250
	Total Award Amount	**$ 44,506**

Erick D. DeWolf

7-15-10

Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *Deployment of Models Predicting the Risk of Disease Epidemics and DON.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Fusarium head blight (FHB) and deoxynivalenol (DON) are best managed by combining production practices that reduce the risk of disease. These production practices include the use of moderately resistant cultivars, rotation with non-host crops, and the timely application of fungicides or biological control products when needed. The disease forecasting models deployed via the Fusarium Head Blight Prediction Center (www.wheatscab.psu.edu) help farm managers evaluate the risk of disease and the need for fungicide applications. The recent registration of efficacious fungicide products further increases the value of the prediction system as part of the integrated management of FHB and DON.

   The models currently deployed through this web-based interface represent the third generation of prediction tools developed by a team of pathologists, meteorologists and computer information technology specialists funded by the USWBSI. The disease models can correctly distinguish years with high disease (>10% field severity) from years with low disease based on summaries of weather observed 7-days prior to anthesis with near 80% accuracy. Within the Prediction Center, these disease prediction models are coupled with state-of-the-art sources of atmospheric models and geo-spatial mapping techniques to produce daily estimates of disease risk in 24 states where epidemics of FHB are most likely to occur.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:

   The accomplishments of this cooperative effort with Penn State University (Paul Knight and Doug Miller) and Ohio State University (Pierce Paul and Larry Madden) include: **1.** Continued deployment of the disease prediction models in 24 states including the support of the state commentary tools, and the platform for testing additional experimental models. **2.** Expanding bias correction to include the states of South Dakota, Nebraska, Kansas and Iowa. **3.** Enhance stability of the data streams and archives data through a dedicated server. **4.** Incorporate additional state Agnets from Kentucky, Oklahoma, and Missouri. **5**. Implement a user survey as a metric for evaluating the impact and utility of the FHB prediction system. **6**. Verification of model performance based on reports of FHB/DON from cooperators – for refinement in the delivery of the current and experimental models. **7**. Increase the atmospheric prediction input used in the disease models from 48 to 72 hours. **8.** Explore information technologies that allow for more efficient communication of commentary developed by stare specialists.

   Impact:

   The prediction tools received over 8,850 visits during the 2009-growing season in the US (April – August). A user survey conducted in 2009 included 593 respondents and indicated that 70% of these users were either farm advisors or farmers. Other users of the system included university extension personnel and members of the grain marketing and milling

industries. The survey also indicated that 77% of the users applied the information provided by the prediction system for direct on-farm management decisions, or providing recommendations for disease management. In 2009, 92% of the users considered the information to be of high or moderate value for their farm operations or organization. The estimated net value of the disease prediction system to U.S. wheat growers exceeds $47 million.

Nearly all of the wheat disease specialists in the 24 states covered by the disease prediction system in 2009 contributed commentary to the disease prediction effort. Specialists in KS, KY, MN, ND, SD and VA each contributed more than 5 updates to the prediction system. Web user statistics indicate that users accessed the commentary more than 500 times in IL, IN, KS, KY, MI, ND, OH, SD, and VA. Efforts to use new technologies to distribute commentaries from state specialists during the 2010 season were established near the end of this grant period. Preliminary results indicate a higher rate of commentary submission and use has resulted.

Efforts to increase the amount of weather observations from independent networks of weather stations (Agnets) were also successful in 2009. Information from MO, KY and additional stations from OK are now fully integrated into the prediction system. The Agnet data were used to provide real-time comparisons of model predictions based on the RTMA (used to generate the base risk maps) and individual weather stations. The FHB Prediction Center was also moved to an independent server in time for the 2010 season. These efforts improved the function and stability of the prediction efforts provided to growers in the US.

Project 2: *A First-Generation Model for DON Prediction in Multiple Wheat Classes in the US.*

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

The management of Fusarium head blight (FHB) requires growers to combine several management approaches including the best available genetic resistance, crop rotation and timely use of fungicides when the environment is conducive for disease development. The cost of these fungicide applications can exceed $20 per acre, and most farmers would like to avoid these additional costs if possible. The USWBSI has sponsored the development of disease prediction models that can help growers evaluate the risk of severe FHB in their area. The current prediction models focus on the visible symptoms of FHB and are able to correctly identify FHB epidemics with near 80% accuracy. The symptoms of FHB are often positively correlated with contamination of the grain by the mycotoxin deoxynivalenol (DON); however, this correlation appears to breakdown in some environments. Researchers at Kansas State University and Ohio State University (Paul and Madden) are now working together to expand the prediction models to address both the symptoms of FHB and DON contamination.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment:

Coordination between the integrated management project and the model development projects (coordinated by P. Paul and OSU) in 2009 resulted in potential 2,254 cases. Over 1,700 of these new cases were not suitable for modeling because they lacked one or more critical pieces of information. The 554 cases that remain were forwarded to KSU for additional quality control and incorporation into the data sets used for model development and validation. This data was used to test preliminary DON models. Initial testing of the models indicated that the accuracy was near 80% based on data used to develop and test the models. Further testing of the experimental models with the 2009 observations and the experimental interface specifically designed to test preliminary models indicated potential inconsistencies with model performance and the models were not released for public use in 2010.

Dr. Denis Shah joined the cooperative project as a post-doctoral researcher employed by Kansas State University. Dr. Shah's initial responsibilities in the modeling project included the quality assessment of the current data sets used in model development and testing. This analysis involves evaluation of the hourly weather and checking disease observations and DON levels for consistency and completeness prior to use in model development. Where possible missing data was replaced and quality issues addressed through communication with cooperators. This analysis resulted in a total data set of over 900 cases that can be used in development of new FHB and DON models. This data set represents both winter and spring market classes of wheat from 11 states. Approximately 31% of the cases are considered epidemics (>10% FHB index). Dr. Shah brings important analytical skills to the modeling project and has begun exploring new modeling approaches that could improve the prediction models. Plans are in place to use novel modeling approaches such a Boosted Logistic Regression and Regression Trees that could improve model performance.

Impact:

The collaborations among researchers of the management and disease prediction efforts have produced valuable information that can be used in the development and testing of FHB and DON prediction models. The cleaning of the current data set and the addition of the 2009 observations improved the data quality in increased the number of cases available to develop and test prediction models for FHB and DON. The current data set available for modeling now consists of more than 900 observations. With such a data set, the modeling effort is now better positioned to develop the next generation of FHB and DON prediction models.

Careful evaluation of the experimental prediction models with research observations from 2009 revealed potential inconsistencies. This effort to test the experimental models prevented the release of prediction models that may have performed poorly for farmers. The additional data and new modeling approaches should help improve the accuracy and consistency of the next generation of prediction models for FHB and DON.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Technical reports (peer-reviewed)

1. Bockus, W. W., De Wolf, E. D. and Wegulo, S. N. 2009. Host resistance correlated with the amount of DON reduction with fungicide on winter whet, 2008. Plant Disease Management Reports 3:CF008.

2. Lingenfelser, J., Bockus, W., De Wolf, E., Fritz, A., Knapp, M., Whitworth, J., Claassen, M., Gordon, B., Heer, W., Kimball, J., Maddux, L., Evans, P., Long, J., Martin, J., Sloderbeck, P., Spangler, M., Schlegel, A., Chen, R., Miller, R., and Shroyer, J. 2009. Wheat Performance Tests with Winter Wheat Varieties: Report of Progress. Kansas Agricultural Experiment Station; No. 1018.

Presentations:

1. De Wolf, E. 2009. A brief history of plant disease risk assessment: successes and challenges. National Meeting of the American Phytopathological Society, August 1-5, Portland OR. Phytopathology 99:S173.

2. De Wolf, E, Knight, P., Miller, D., Paul, P., and Madden, L. 2009. Evaluating the use and potential impact of Fusarium head blight prediction models in the U.S., 2009. In: S. Canty, A. Clark, J. Mundell, E. Walton, D. Ellis, and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2009. Dec 7-9; Orlando, FL. Lexington, KY: University of Kentucky. Pp. 40.

3. Nita, M., De Wolf, E., Paul, P., Madden, L., Stein, J., Ali, S., Wegulo, S. 2009. Prediction of deoxynivalenol accumulation for Fusarium head blight of wheat using empirical and mechanistic modeling approaches. Phytopatholgy 99:S94.